

Coleman; on sanitary arrangements and house-building in towns, by Mr. James Sellars; on Egyptian obelisks, by Mr. T. L. Patterson; on producing cast iron or ingot iron from crude or pig iron, by Mr. W. Gorman; on the heat-restoring gas furnace and heating by radiation, by Mr. W. Gorman; on uncertified deaths, by Dr. Glaister; on the spread of disease by manure poisoning, by Dr. E. Duncan; and on the form of the human skull, by Prof. Cleland. The two maps, prepared by Mr. Ravenstein, and presented to the Society by Mr. James Stevenson, are specially valuable as showing the most recent results of African travel.

During the session M. Louis Pasteur, Prof. Asa Gray, and Rev. John Kerr, LL.D., were elected honorary members, and Mr. George Anderson, lately M.P. for Glasgow, and now Master of the Mint, Melbourne, was elected a corresponding member. The Graham medal was awarded to Mr. E. C. C. Stanford for his researches on algin. The Society at present has 18 honorary, 11 corresponding, and 691 ordinary members, and in addition to the ordinary meetings, there are sections for architecture, chemistry, biology, sanitation and social economy, and geography and ethnology.

AN EARTHQUAKE INVENTION

WE have been requested to publish the following correspondence:—

Royal Observatory, Edinburgh, June 5, 1885

MY DEAR MR. DAVID STEVENSON,—At p. 248 of the new British Association volume for 1884 there is a section on "Experiments on a Building to Resist Earthquake Motion," which reads amazingly like your paper of twenty years ago; but yet it is not that, for your name does not enter, and they have in a way got round the letter of your invention by employing, in place of your bronze balls in shallow bronze basins, cast iron balls and cast-iron plates, "with saucer-like edges" for the lower basins; and for the upper basins, "cast iron plates slightly concave, but otherwise similar to those below."

Against such men would any patent be safe? though you may not have taken out any patent for your philanthropic invention for saving life in earthquake-persecuted countries; but the whole section is the most indubitable approval of your methods and principles that could well have been proposed by any one. Certainly it transcends anything that could have ever entered the mind of

Yours ever very sincerely,

C. PIAZZI SMYTH

Edinburgh, June 11, 1885

DEAR SIR,—Very many thanks for your letter to my father pointing out the report of the British Association on earthquakes for 1884, which I had not seen. My father, from the state of his health, is unfortunately unable to take the matter up himself, but if you will permit me to publish your very interesting and well-put letter in NATURE it will give the honour of the invention to whom the honour is due. My father, who read your letter with great interest, begged to be remembered to "his old friend." In order to save you the trouble of writing again I shall assume, if I do not hear from you in a few days, that you have no objection to your letter being published.

I may mention that the balls for the Japanese aseismic arrangements for the towers were made of cast iron, and those for the tables in the light-rooms were of gun-metal.

Yours very truly,

D. A. STEVENSON

Professor Piazza Smyth, &c., &c.

Westford House, Droitwich, June 13, 1885

DEAR MR. D. A. STEVENSON,—Yours of the 11th has reached me here; and, as I left Edinburgh on that day, it was a happy thought of yours to say that, if you did not hear from me soon you would assume my consent to your making some public use of my letter to your worthy father. For, in so far as I wrote it at all, I am ready to stand by it before many or few.

But it was only the beginning of what might have been said; and that I trust you will have perceived, and will supply some of the remaining *notanda*, such as the B.A. man praising up the system for so decidedly relieving the ball-supported building from all the *sharp*, destructive effects of an earthquake-shock, and leaving only a gentle to-and-fro motion on the balls;

—because this was so admirably illustrated on your father's experimental model at Milton House—by the ease and safety with which the model lighthouse standing on balls in basins was knocked all about the yard by men with sledge-hammers, when they struck only the lower basins, or what they were fixed on as representing solid, yet earthquake-affected, ground; but the moment they struck the base of the lighthouse taken off the basins and balls and planted on the ground, down toppled lantern and lamps with such a fracture, that no more experiments could be made that day.

Then, again, your father had duly allowed that his system would not defend from vertical earthquake-shocks, but he hoped that they would be far more rare at any one place than horizontal shocks spreading all around and far from the places of vertical action; and exactly so says the B.A. man for himself and his imitation balls and basins.

And then he concludes with that he does hope for so much alleviation to human suffering in earthquake regions from the large amount of safety that balls and basin supports for dwellings must give in a general way that seismic science will be elevated in the eyes of the people, or something to that effect. To all which of course you can perfectly agree, both in your own and your father's name. I can mention that the turning-point with him as to the practicability of the scheme was when he ascertained by rigid and calm scientific measures that the amount of absolute motion which had done the most mischief in some of the worst Italian earthquakes was not more than three inches, so that it came legitimately within the compass of the means he first suggested, and R.S.S. Arts duly stamped with its approval ten years ago.

Hereabouts is a different earth effect—viz. the High Street, so called, of Droitwich—going down slowly but surely to fill up the vacancies occasioned below by the ceaseless bringing up of salt-rock dissolved in water pumped by numberless steam-engines, and furnishing, it is said, half the human family with that one necessary mineral condiment, salt; and so much vapour of it is in the air that mere residence here for a time is said to cure rheumatism and other complaints, even without taking the celebrated brine baths, of ten times the saltiness of the ocean itself.

Yours very truly,

C. PIAZZI SMYTH

P.S.—The spectroscopic salt line D is preternaturally strong in the air here; "D" might stand for Droitwich.

SCIENTIFIC SERIALS

Journal of the Russian Chemical and Physical Society, vol. xvii. fasc. 1.—Annual reports of the Society.—On the isomerism of hydrocarbons according to the theory of substitution, by M. Menshutkin (analysed in another column).—On the preparation of hemines, by M. Schalfeyeff.—On its crystalline forms, by A. Lagorion (with plates).—Notes on an apparatus for washing precipitates; on the oxidation of aromatic amines; on the action of alcohol on diazo compounds.—On the isomerism of solutions, by W. Alexeyeff.—On the same, by D. Konovall.—Minutes of proceedings of the physico-chemical section of the Moscow Society of amateurs of Natural Sciences.—On the electrolytic figures of Nobili and Gebhard in the magnetic field, by W. Stchegliaeff (with a plate).—On the collision of absolutely rigid bodies, by N. Schiller, being a mathematical inquiry, to show that the invariability of the *vis viva* can be established by the geometrical determination of the absolute invariability of the systems.—On the dilatation of liquids, by K. Jouk. Researches at the University of Kieff proved that common ether, ethylic alcohol, sulphurous anhydride, diethylamine, and chloric ethyl comply with the formula $v = a + b \log(\tau - t)$.—Polemics between MM. Kraewitsch, Stoletoff, and Petroff.

Vol. xvii., fasc. 2.—Thermal data for hydrocarbon compound o bromide of aluminium, by G. Gustavson. The figures found by Berthelot, give for the molecule AlBr_3 a heat of dissolution equal to 170,600 units, M. Gustavson has found, from a series of six determinations, an average of 180,237 (from 179,926 to 180,763). When taking $\text{AlBr}_3 \cdot 3(\text{C}_2\text{H}_5)$, the number of calories received was nearly 168 (from 168,001 to 168,567).—On diallyloxalic acid, and on the preparation of oxalic ether, by E. Schatzky.—On the formation of carbonates of strontium, barium, and calcium, by J. Bevad, being an inquiry into the rapidity of reactions.—On the change of colours of coloured surfaces under artificial light, by Th. Petrushevsky.

Sitzungsberichte der Naturwissenschaftlichen Gesellschaft Isis, Dresden, 1884.—Osteology of *Rana temporaria*, L., and *Rana esculenta*, L., by H. Reibisch.—Note on *Testudinaria elephantipes*, Lindl., and *Welwitschia mirabilis*, Hook., by Prof. O. Drude.—Biographical notices of the late Dr. H. R. Göppert of Breslau, of F. von Hochstetter of Vienna, and of Dr. W. Gonnermann of Coburg, by Dr. Geinitz.—Mineralogical and geological results of a journey to Italy in the year 1884, by A. Purgold.—On a prehistoric necropolis at Trög, near Rosegg, Carinthia, by W. Osborne.—On some metal objects recently discovered at Jessen, near Lommatsch, by Dr. Caro.—On the increase of accidents from lightning in the Kingdom of Saxony, by Johannes Freyberg.—Remarks on some urns and other archaeological remains lately discovered at Uebigau, near Dresden, by Dr. J. von Deichmüller.—Memoirs on the phanerogamous flora of the Voigtland district, Saxony, by A. Artzt.—On the granites, gneiss, crystallised limestones, schists, and other primitive rocks occurring in the districts north of the Zittau and Jeschken ranges, by Emil Danzig.

Rendiconti del Reale Istituto Lombardo, May 7.—Results so far obtained from the study of the chief ichthiofauna of the Cretaceous period, by Prof. F. Bassani. This elaborate monograph concludes with a comparative table of the fossil fishes of Pietravarra, Voiron, Comen, Lesina, Crespano, Monte S. Agata, Groditschitz, Tolfa, and Hakel.—A contribution to the study of etherification by double decomposition: formation of the nitrous ether of allylic alcohol, by Prof. Giacomo Bertoni.—Further remarks on the functions which satisfy the differential equation $\Delta^2 u = 0$, by Prof. Giulio Ascoli.—Remarks on the modifications introduced by the present Minister, Pessina, into the Penal Code proposed by Savelli, by E. A. Buccellati.

SOCIETIES AND ACADEMIES LONDON

Royal Society, June 18.—“Regional Metamorphism,” by Joseph Prestwich, M.A., F.R.S., Professor of Geology in the University of Oxford.

Metamorphic rocks have been divided into two classes—(1) Those in which the change has been caused by contact with heated eruptive rocks; (2) Those extending over wider areas, in which the rocks are in no apparent relation to eruptive or igneous rocks. The first has been termed *Contact Metamorphism*, and the second *Normal or Regional Metamorphism*, the latter two terms having been used to express the same phenomena and treated as synonymous.

The author, however, for reasons to be assigned, proposes, while retaining the use of both the latter terms, to apply them differently. Normal metamorphism he would confine, as hitherto, to the changes caused by the heat due to depth, on the supposition of the existence of a heated central nucleus of the earth, while he would use the term *regional metamorphism* to denote changes effected by the agency of the physical causes to which Mr. Mallet referred the fusion of the volcanic rocks, namely, *the heat produced locally within the crust of the earth by transformation into heat of the mechanical work of compression, or of crushing of portions of that crust.*

The primary object of Mr. Mallet's experiments was to ascertain the force required to crush portions of various rocks of given size, and to determine the quantity of heat evolved by the process. For this purpose the work done was measured by the number of cubic feet of water at 32° F. that could be converted into steam of one atmosphere (or at 212° F.) by the estimated heat evolved by the crushing of 1 cubic foot of each class of rock.

With all the harder rocks the heat produced in the metal surroundings by the complete crushing was easily perceptible by the hand, and was so great with some of the granites and porphyries as to necessitate a delay for the apparatus to cool. Both Mr. Mallet and Prof. Rankine were of opinion that in the crushing of a rigid material such as rock *almost the entire mechanical work* (with the exception of a small residue of external work) reappears as heat. It was further shown that, even in the most rigid bodies, crushing begins by compression and yielding, and that at this stage heat begins to be evolved.

Consequently the work thus developed being transformed into heat, that heat will be greatest along those lines or planes at places where the movement and pressure, together constituting the work, is greatest; whence Mallet concluded that along or about such axial lines of concentrated compressive and crushing

work the temperature may locally rise to a red heat, or even to that of fusing the rocky materials crushed and of the pressing-together-walls themselves adjacent to them. This was in his opinion the real nature and origin of the volcanic heat as now produced on the globe.

Although the hypothesis fails for various reasons in its application to vulcanicity, especially for the reason that the great lines of disturbances and compression of the Alps, Pyrenees, and other mountain chains are free from either active or extinct volcanoes, there is, nevertheless, reason to believe that this source of heat may have been adequate to produce great molecular changes in the rocks along the lines of disturbance and upheaval, though the extreme results obtained by entire crushing by mallet would rarely or ever occur in nature. It is, however, precisely along such lines that not only are older rocks metamorphosed, but rocks of Cretaceous and Tertiary age—which usually have not been affected by normal metamorphism—coming, in these mountain-chains, under the influence of the disturbing forces, have undergone a change analogous to that produced by normal metamorphism.

Objections have been raised to the explanation offered in some cases of alteration of sedimentary strata in mountain-chains by ordinary normal metamorphism, on the grounds that unaltered strata alternate with altered strata. Sometimes this may be explained by inversion of the strata, or, where that is not the case, it may be due to the circumstance that differences of mineral composition, or in the proportion of the water of imbibition, have caused the metamorphism to affect different beds in different degrees. On the theory of *regional metamorphism*, in the sense the author would use it, another explanation suggests itself by the way in which differences in the resistance of the rocks develop different quantities of heat. Mr. Mallet has shown by experiments on the compressibility of rocks at Holyhead that, although certain slate-rocks were compressed by precisely the same force before their elastic limits were passed, yet, owing to differences in their compressibility, the heat developed in the rocks when released would render the quartz-rock nearly three times as hot as the slate-rock. In this manner, therefore, it seems possible to account for a special and restricted metamorphism of the strata in mountain-chains, and for its frequently localised occurrence.

The remarkable changes which take place in the condition of the coal of Pennsylvania, as it ranges into the Appalachian Mountains, may also be owing more probably to *regional* than to normal metamorphism. This mountain-range consists of a series of great parallel folds increasing in acuteness as the central axis is approached. Eruptive rocks are absent, but, nevertheless, the strata as they approach the central chain become more crystalline, and the coal, which at a distance is ordinary bituminous coal, passes into anthracite and even graphite. The late Prof. H. D. Rogers divided this great coal-field into four basins. The coal in the less-disturbed district near the Ohio River, where the flexures are extremely gentle and wide apart, contains from 40 to 50 per cent. of volatile matter; in the wide basin further east it decreases to 30 or 35 per cent.; in the basins of the Alleghany range, in which, although there are no important dislocations or great flexures, there are some extensive and symmetrical anticlinal axes of the flatter form, the proportion of the volatile matter in the coal varies from 16 to 22 per cent.; while in the most easterly chain of basins which are associated with the boldest flexures and greatest dislocations, with close plications and inversions of strata, the quantity of volatile matter in the coal is reduced to 6 to 14 per cent.

A somewhat analogous instance is presented by the Carboniferous series of Belgium. The excessive squeezing, faulting, and inversion which the Coal-measures have undergone on the flanks of the axis of the Ardennes, is there accompanied by an alteration of the highly bituminous coals into dry coals and into anthracite; while the Carboniferous and Devonian limestones amidst the sharply convoluted and folded strata of the Ardennes are there, as they are also on the line of the same disturbance in the Boulonnais, transformed very generally into crystalline marbles. The few exposures of eruptive rocks are all on a small scale, and affect the adjacent rocks only by contact metamorphism. It is probable that the anthracite of South Wales is the result of similar *regional metamorphism*.

In the case of contact metamorphism the changes were produced by great heat, for the eruptive rocks must have had a temperature of 3000° to 4000° F. or more; while in the case of normal metamorphism it is evident that the changes produced